BECHTEL JACOBS
Bechtel Jacobs Company LLC

DOE Contract No. DE-AC05-03OR22980
Job No. 23900
LTR-PAD/EP-AC-05-0088
December 28, 2005

received
1/4/06

44

RECORD COPY

Mr. William E. Murphie, Manager
Portsmouth/Paducah Project Office
U.S. Department of Energy
1017 Majestic Drive, Suite 200
Lexington, Kentucky 40513

Dear Mr. Murphie:

DE-AC05-03OR22980: ***Remedial Design Work Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** **(DOE/OR/07-2214&D2)**

Enclosed for Department of Energy (DOE) Resource Conservation and Recovery Act (RCRA) certification and submission to the Commonwealth of Kentucky and United States Environmental Protection Agency (EPA) is the captioned certified document and the Comment Response Summary for regulator comments received. Also enclosed is suggested text for submitting the captioned document to the Commonwealth of Kentucky and EPA for approval. Consistent with our current schedule milestones, the document should be issued no later than December 29, 2005. The DOE transmittal letter should be provided to Bryan Clayton of my staff who will coordinate the document distribution. Distribution will be performed by TetraTech, Inc., consistent with the D2 Standard Distribution List.

If additional information is needed, please contact Bryan Clayton at (270) 441-5412.

Sincerely,

for

James R. Kannard
Paducah Manager of Projects

I-04614-0024

JRK:BJC:amc

Enclosures: As stated

c/enc: B. J. Clayton
D. W. Dollins, PPPO/PAD
File–EMEF PAD DMC–RC

c: G. A. Bazzell, PPPO/PAD
R. H. Blumenfeld, PPPO/LEX
J. P. Farrell
L. L. Fleming
L. W. Hurst
R. M. Knerr, PPPO/PAD
J. W. Morgan
R. D. Nalley
B. Phillips, Navarro
P. W. Willison

REVIEWED FOR CLASSIFICATION
MB 1.5.06
Initials Date
UNCLASSIFIED

/

Comment Response Summary

for the

Remedial Design Work Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

(DOE/OR/07-2214&D1)

Prepared for
U.S. Department of Energy
Office of Environmental Management

Comment Response Summary for the

Remedial Design Work Plan for the Interim Remedial Action for the

Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

(DOE/OR/07-2214&D1) issued August 2005

NO.	SECTION	REVIEW COMMENT	RESPONSE
1	General	KDEP: Given the possibility of cross contamination between subsurface horizons (e.g., DNAPL running down a borehole) and its negative effect upon confirmation sampling results, the Division strongly advises against the use of multi-port wells during construction of this action.	The remedial design work plan does not document the type of groundwater monitoring well to be installed by the subcontractor. The Remedial Design Report will detail the type of monitoring wells to be installed. The DOE is aware of the concern for cross-contamination in such wells. The DOE will take this into account when preparing the design of the monitoring systems.
2	General	KDEP: Good hydraulic control is a critical part of any direct heating operation such as that to be undertaken at C-400. There must be a means in place to show that TCE and other VOCs are being captured and treated rather than simply leaving the treatment zone.	The Remedial Design Report will document the technical approach to treating the contaminants during the operations.

Comment Response Summary for the

Remedial Design Work Plan for the Interim Remedial Action for the

Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

(DOE/OR/07-2214&D1) issued August 2005

NO.	SECTION	REVIEW COMMENT	RESPONSE
3	Section 1.2, Page 4, 4th Paragraph 2nd Bullet	KDEP: This bullet indicates that the remedial action work plan will set forth the criteria to be used to determine when the direct heating system will be de-energized. In addition, the bullet states that the shut-down criteria "will apply for determining when asymptosis occurs" but fails to indicate that heating stabilization must also be taken into account. The first statement is inconsistent with language in the ROD that states that the design documents, and not the RAWP, will initially present this information. While it is ok for the RAWP to reiterate this information, the information should first be presented in the design documents as required in the ROD. Modify the text so as to indicate that the system shut-down criteria are to first be presented in the design document (e.g., the 60%or 90% design). Also modify the bullet text so as to make it clear that the criteria for both asymptosis and heating (temperature) stabilization will be presented in the design documents.	 The document has been modified consistent with the signed Record of Decision.
4	Section 3.2, Page 15, 1st Paragraph, Last Sentence	KDEP: The last sentence of this paragraph is somewhat confusing. The text seems to imply that an MCL exists for TCE in soils. Please reword the text so that it is clear that the MCL being referred to is that for TCE in groundwater as measured at the point of exposure.	 The sentence has been revised to clarify the MCL is for TCE in the groundwater.
5	Section 3.2, Page 16, 1st Paragraph, Last Sentence	KDEP: The last sentence should make it clear that the Remedial Design Report will specify both the criteria for determining when asymptosis is achieved and when heating stabilization has been achieved. Two criteria must be met before system shutdown can occur. This must be clearly understood by the reader.	 The sentence has been modified consistent with the signed Record of Decision.

4

Comment Response Summary for the

Remedial Design Work Plan for the Interim Remedial Action for the

Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

(DOE/OR/07-2214&D1) issued August 2005

NO.	SECTION	REVIEW COMMENT	RESPONSE
6	Section 3.2, Page 16, 5^{th} Paragraph	KDEP: Please indicate within this paragraph that the Sampling and Analysis Plan will provide to the regulators as well as to BJC. The regulators must be given the opportunity to provide input regarding the SAP. Also replace the words "level of contamination" with a more accurate description of what is actually being measured, mainly the time at which point of diminishing returns has been reached.	The text has been modified to indicate the Sampling and Analysis Plan will be provided to the regulators for review and comment. Also, "Level of contamination" has been replaced with: "Operation of the Electrical Resistance Heating array would cease when the monitoring system indicates that heating has stabilized in the subsurface and the contaminant recovery diminishes to a point where significant additional decreases in this rate of recovery are not anticipated (i.e., the rate of removal of TCE and other VOCs becomes asymptotic)."
7	Section 3.4, Page 18, 5^{th} Bullet	KDEP: This statement is inconsistent with text found on page 16 stating that the Remedial Design Report will contain the shutdown criteria. Please modify this text as necessary.	The reference to the RAWP has been changed to RDR.
8	Section 5, Page 19, 6^{th} Paragraph	KDEP: The second sentence in the paragraph states "The RDR will include only the contractually binding drawings and specifications that will be utilized by the subcontractor to perform the remediation." Please be aware that the RDR's content should match that required in Appendix D of the Federal Facility Agreement.	The sentence has been modified to state that the RDR will include the construction drawings and specifications as well as other content as required by the FFA for the final Remedial Design Report.
9	Section 5, Page 20, 1^{st} Paragraph	KDEP: The second to last sentence is somewhat confusing and should be reworded.	The sentence has been clarified.

Comment Response Summary for the

Remedial Design Work Plan for the Interim Remedial Action for the

Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

(DOE/OR/07-2214&D1) issued August 2005

NO.	SECTION	REVIEW COMMENT	RESPONSE
10	Section 5.1, Page 20, 3rd Paragraph, Last Sentence	KDEP: Reword the sentence as follows: "The final drawings and specifications must be sealed/stamped by a Professional Engineer registered in the Commonwealth of Kentucky."	The sentence has been modified.
11	Section 5.2.2, Page 21, 2nd Paragraph	KDEP: Remove the words "to the extent practicable" from the first sentence of this paragraph. It should be made clear in the text that, in the case of interim remedial actions under CERCLA, an ARAR must be met unless it is waived or it can be shown that the ARAR in question will be met as a part of the final action.	The first sentence of the referenced paragraph has been deleted and replaced with the following language. *As set forth in the signed ROD, this interim action complies with ARARs for the scope of this interim action. While this interim action is not expected to attain the MCL for TCE in the RGA at the time treatment is complete, the action satisfies the requirement in 40 CFR 300.430(f)(1)(ii) for interim actions to meet ARARs.*
12	Section 7, Page 23	KDEP: The citation for DOE 2005a. is incorrect. The ROD is a D2/ R2 document, not a D3. Please correct.	Corrected.

DOE/OR/07-2214&D2

Remedial Design Work Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Cleared for Public Release

7

Tetra Tech, Inc.

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

DOE/OR/07-2214&D2

Remedial Design Work Plan for the Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued — December 2005

Prepared by
Tetra Tech, Inc.
Oak Ridge, Tennessee
under subcontract 23900-BA-ES008

Prepared for the
U.S. Department of Energy
Office of Environmental Management

BECHTEL JACOBS COMPANY LLC
managing the
Environmental Management Activities at the
East Tennessee Technology Park
Y-12 National Security Complex   Oak Ridge National Laboratory
Paducah Gaseous Diffusion Plant   Portsmouth Gaseous Diffusion Plant
DE-AC05-98OR22700 and DE-AC05-03OR22980
for the
U.S. DEPARTMENT OF ENERGY

Blank Page

CONTENTS

Blank Page

FIGURES

TABLES

Blank Page

ACRONYMS

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BJC	Bechtel Jacobs Company, LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFC	Certified for Construction
DNAPL	dense nonaqueous phase liquid
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ES&H	Environmental, Safety, and Health
FFA	Federal Facilities Agreement
HU	hydrogeologic unit
KDEP	Kentucky Department for Environmental Protection
LUC	land use control
MCL	maximum contaminant level
MMES	Martin Marietta Energy Systems, Inc.
O&M	operation and maintenance
OU	operable unit
PGDP	Paducah Gaseous Diffusion Plant
ppb	parts per billion
QA/QC	quality assurance/quality control
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act of 1976
RDR	Remedial Design Report
RDWP	Remedial Design Work Plan
RGA	Regional Gravel Aquifer
ROD	Record of Decision
STR	Subcontract Technical Representative
SWMU	solid waste management unit
TCE	trichloroethylene
UCRS	Upper Continental Recharge System
VOC	volatile organic compound
WAG	waste area grouping

Blank Page

EXECUTIVE SUMMARY

The interim remedial action for the Groundwater Operable Unit volatile organic compound (VOC) at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant (PGDP) near Paducah, Kentucky, addresses the potential threat to human health and the environment from the release or potential release of hazardous substances into the environment from the source zone comprised of trichloroethylene (TCE) and other VOCs at the C-400 Cleaning Building area. This interim remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, and is the response action selected in the *Record of Decision* [ROD] *for Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2005a). The U.S. Department of Energy (DOE) is the owner and the lead agency for PGDP cleanup activities. Both the U. S. Environmental Protection Agency and the Kentucky Department for Environmental Protection are oversight agencies for the DOE's environmental restoration of PGDP.

The interim remedial action technical approach for reducing VOCs at the C-400 Cleaning Building has the following primary objectives:

- Reduce exposure to contaminated groundwater by reducing the source concentrations of TCE and other VOCs in the Regional Gravel Aquifer (RGA) in the C-400 Cleaning Building area, thereby reducing the migration of these contaminants to off-site points of exposure;

- Prevent exposure to contaminated groundwater by on-site industrial workers through institutional controls (e.g., excavation/penetration permit program); and

- Reduce contamination comprised of TCE and other VOCs found in Upper Continental Recharge System (UCRS) soil at C-400 Cleaning Building area to minimize the migration of these contaminants to RGA groundwater and to off-site points of exposure.

The major components of the selected remedy include the following:

- Reduction in the concentration of TCE and other VOCs in the soils in the C-400 Cleaning Building area through removal and treatment using Electrical Resistance Heating in both the UCRS and RGA;

- Collection of post sampling results;

- A remedial design investigation to further determine the areal and vertical extent of TCE and other VOC contamination in the C-400 Cleaning Building area to determine optimum placement of the remediation system; and

- Implementation of land use controls (LUCs) at the C-400 Cleaning Building area.

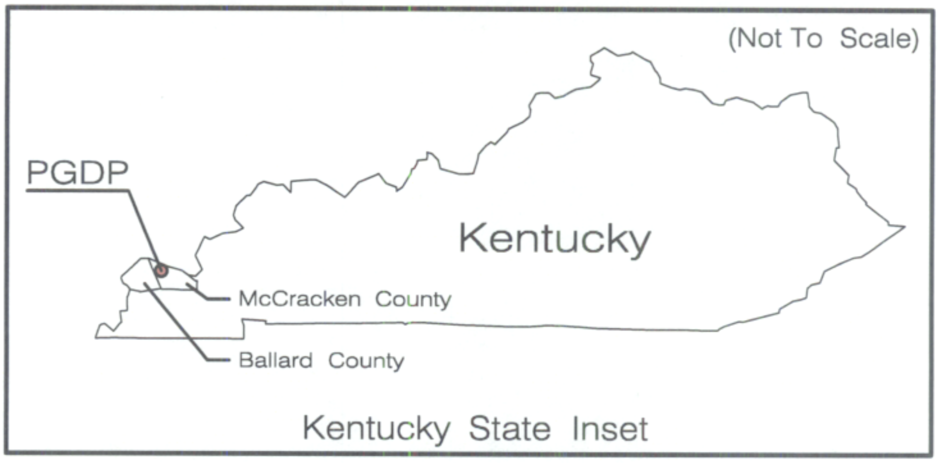
This Remedial Design Work Plan defines the scope of activities and approach that is necessary to implement the selected remedy as identified in the ROD (DOE 2005a) for this remedial action. The remedy consists of volatilization and removal of TCE and other VOCs from contaminated groundwater by application of Electrical Resistance Heating in an area located south of the C-400 Cleaning Building, therefore further reducing contribution to the off-site groundwater plumes. This plan specifically addresses the location of the project, the nature of the work, the major work activities required to perform the design for the interim remedial action, the schedule, and the special project applicable or relevant and appropriate requirements as stated in the ROD.

1. INTRODUCTION

This Remedial Design Work Plan (RDWP) documents the design approach that will be followed to implement the interim remedial action for the Groundwater Operable Unit (OU) for volatile organic compounds (VOCs) at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant (PGDP) near Paducah, Kentucky (Fig. 1). The interim remedial action addresses the potential threat to human health and the environment from the release or potential release of hazardous substances into the environment from the source zone comprised of trichloroethylene (TCE) and other VOCs at the C-400 Cleaning Building area (Fig. 2).

This interim remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and is the response action selected in the *Record of Decision* [ROD] *for Interim Remedial Action for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2005a). The U.S. Department of Energy (DOE) is the owner and lead agency for PGDP cleanup activities. Both the U. S. Environmental Protection Agency (EPA) and the Kentucky Department for Environmental Protection (KDEP) are oversight agencies for the DOE's environmental restoration of PGDP. PGDP was placed on the National Priority List in 1994. Section 120 of CERCLA required the negotiation and implementation of the PGDP Federal Facility Agreement (FFA) that integrates regulatory requirements from Resource Conservation and Recovery Act of 1976 (RCRA) and CERCLA. Section 104 of CERCLA addresses the mitigation of releases or threatened releases of hazardous substances to the environment through response action. Executive Order 12580, "Superfund Implementation," delegates to the DOE the authority for response actions for DOE facilities. Bechtel Jacobs Company, LLC (BJC) is the current DOE prime contractor for the environmental restoration and waste management activities at the plant.

Elevated concentrations of the VOC TCE and its breakdown products in subsurface soils and groundwater indicate that dense nonaqueous phase liquid (DNAPL) source areas exist within the Upper Continental Recharge system (UCRS) soils and the Regional Gravel Aquifer (RGA) southeast and southwest of the C-400 Cleaning Building. Once released, DNAPLs can migrate downward through the subsurface, with a portion being trapped in the pore spaces of soil. During the Waste Area Grouping (WAG) 6 Remedial Investigation (DOE 1999a), which included the area around the C-400 Cleaning Building, the TCE concentrations detected in the RGA indicated a maximum concentration of 701,000 parts per billion (ppb) in groundwater (64% of the maximum solubility of TCE in water) southeast of the C-400 Cleaning Building, suggesting that DNAPL has penetrated the RGA and is acting as a secondary source of groundwater contamination. The response action selected in the ROD (DOE 2005a) is considered an interim remedial action. It will reduce TCE and other VOC contamination in soils and groundwater in the C 400 Cleaning Building treatment area, thereby contributing to the final cleanup of the groundwater operable unit.



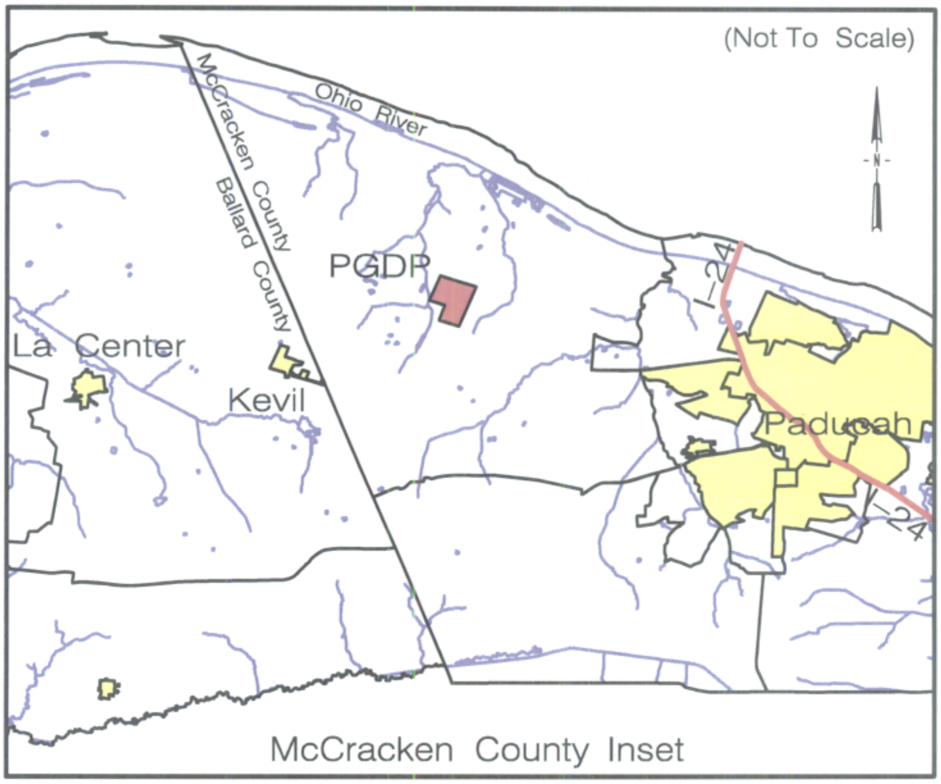


Fig. 1. Regional location map for Paducah Gaseous Diffusion Plant, Kentucky.

Fig. 2 C-400 Cleaning Building Area Site Map

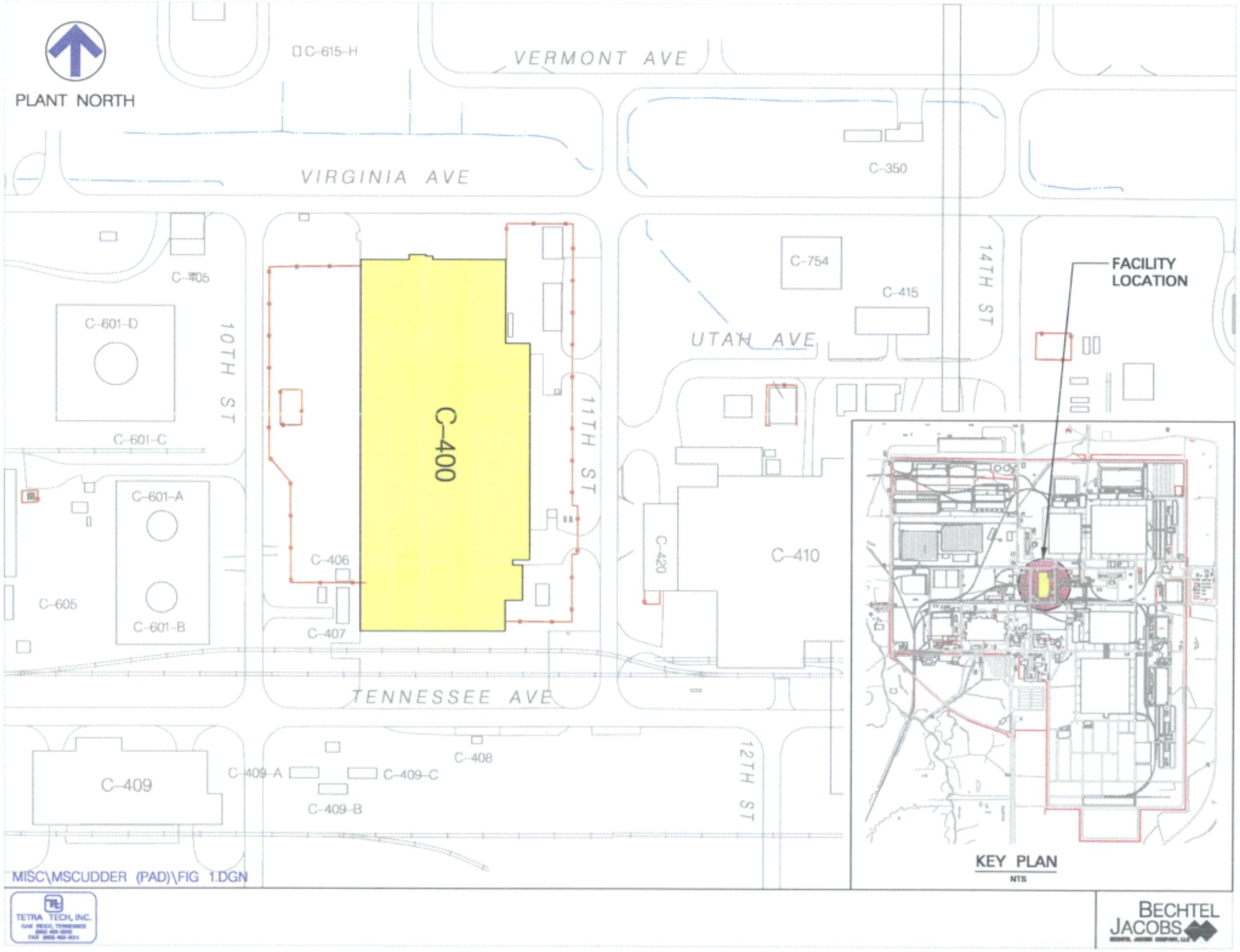


Fig. 2. C-400 Cleaning Building area site plan.

21

The RDWP is divided into seven sections. The introductory section details the purpose and scope of the RDWP; the interim remedial action selected as identified by the ROD; the method of accomplishment; and the project organization and the roles and responsibilities for the remedial action task. The site background is presented in Sect. 2 inclusive of site history, geophysical definition, and the VOCs of concern. Section 3 presents the technical approach including the remedial design objectives and the regulatory considerations necessary to develop the design criteria and supporting assumptions. Section 4 of the RDWP describes the remedial design planning activities inclusive of project management and remedial design oversight by the subcontractor's Environmental, Safety, and Health (ES&H) activities and quality assurance. The remedial design detailed scope activities are presented in Sect. 5 while the proposed project schedule for the remedial design of the remedy is given in Sect. 6. Section 7 provides the references utilized during the remedial design document preparation.

1.1 PURPOSE AND SCOPE OF THE REMEDIAL DESIGN WORK PLAN

The *Feasibility Study for the Groundwater Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001a) was submitted to the EPA and Commonwealth of Kentucky on August 27, 2001. The Feasibility Study provided an evaluation of alternatives for remediation of various VOC sources to the Groundwater OU and described the strategy for addressing these sources at the PGDP. Subsequently, the *Proposed Remedial Action Plan for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2004a) was approved by the EPA and the Commonwealth of Kentucky, and a public comment period was held from June 2, 2004 to July 16, 2004. Ultimately, the ROD (DOE 2005a) documenting the selected interim remedial action for the Groundwater OU VOC source zone, comprised primarily of TCE at the C-400 Cleaning Building, was signed in August 2005.

This RDWP defines the scope of activities necessary to design the engineering drawings and specifications for use in implementing the interim remedial action selected in the ROD. This RDWP specifically addresses the location of the project, the nature of the work, the major work activities required to perform the design for the interim remedial action, the schedule, and the special project applicable or relevant and appropriate requirements (ARARs) as stated in the ROD (DOE 2005a).

1.2 SELECTED REMEDY

The selected remedy as identified in the ROD (DOE 2005a) consists of volatilization and removal of TCE and other VOCs by application of Electrical Resistance Heating. The major components of the selected remedy include the following:

- A remedial design support investigation to further determine areal and vertical extent of the contamination in the C-400 Cleaning Building area to determine optimum placement of the remediation system.

- Removal and treatment of TCE and other VOCs from the contaminant source zone in the UCRS and RGA at the C-400 Cleaning Building area using Electrical Resistance Heating. The operation of Electrical Resistance Heating would cease when monitoring indicates that heating has stabilized in the subsurface and when recovery diminishes to a point at which the rate of removal of TCE, as measured in the recovered vapor, becomes asymptotic. The forthcoming remedial action design documents will include criteria setting forth the requirements and approach that will apply for determining when asymptosis is achieved and heating stabilization has occurred, signaling when operation of the Electrical Resistance Heating System will cease.

- Implementation, maintenance, enforcing and reporting of LUCs on the C-400 Cleaning Building area.

- Continuation of groundwater monitoring of the source and dissolved-phase plumes because contamination would remain in place following the interim remedial actions.

1.3 ROLES AND RESPONSIBILITIES

The project organization chart showing relationships of key personnel and organizations is shown in Fig. 3.

- DOE Project Manager – Serves as the point of contact with regulatory agencies and directs the overall completion of the interim action in accordance with the approved ROD and remedial design. Establishes baseline scope, schedule, and budget and serves as the primary interface for environmental management activities implemented by DOE's Prime Contractor.

- DOE Prime Contractor Project Manager – Serves as the primary point of contact with DOE to implement the interim remedial action. Performs work in accordance with the baseline scope and schedule and directs the day-to-day activities of DOE Prime Contractor personnel.

- DOE Prime Contractor Subcontract Technical Representative (STR) – Serves as the DOE Prime Contractor primary point of contact with the subcontractor during interim remedial design and remedial action activities. Verifies work is performed in accordance with the subcontract document and approved work plans.

- DOE Prime Contractor Lead Engineer – Performs technical review of the engineering submittals and ensures that the design meets the design objectives and the DOE Prime Contractor requirements.

- Subcontractor Project Manager – Serves as the interim remedial action subcontractor's primary point of contact with the STR and is responsible for the performance, quality, schedule, and budget. Provides overall project direction and execution, implements corrective actions as necessary, verifies compliance with ES&H requirements, and participates in the readiness review.

- Subcontractor Quality Assurance/Quality Control (QA/QC) Manager – Verifies all work is completed in accordance with the Quality Assurance Plan. Develops QA/QC procedures and implementing administrative procedures that govern both technical and non-technical work.

- Subcontractor Project Superintendent – Oversees all field activities and verifies that field operations follow established and approved plans and procedures. Interfaces with the Subcontractor Project Manager and STR during field activities.

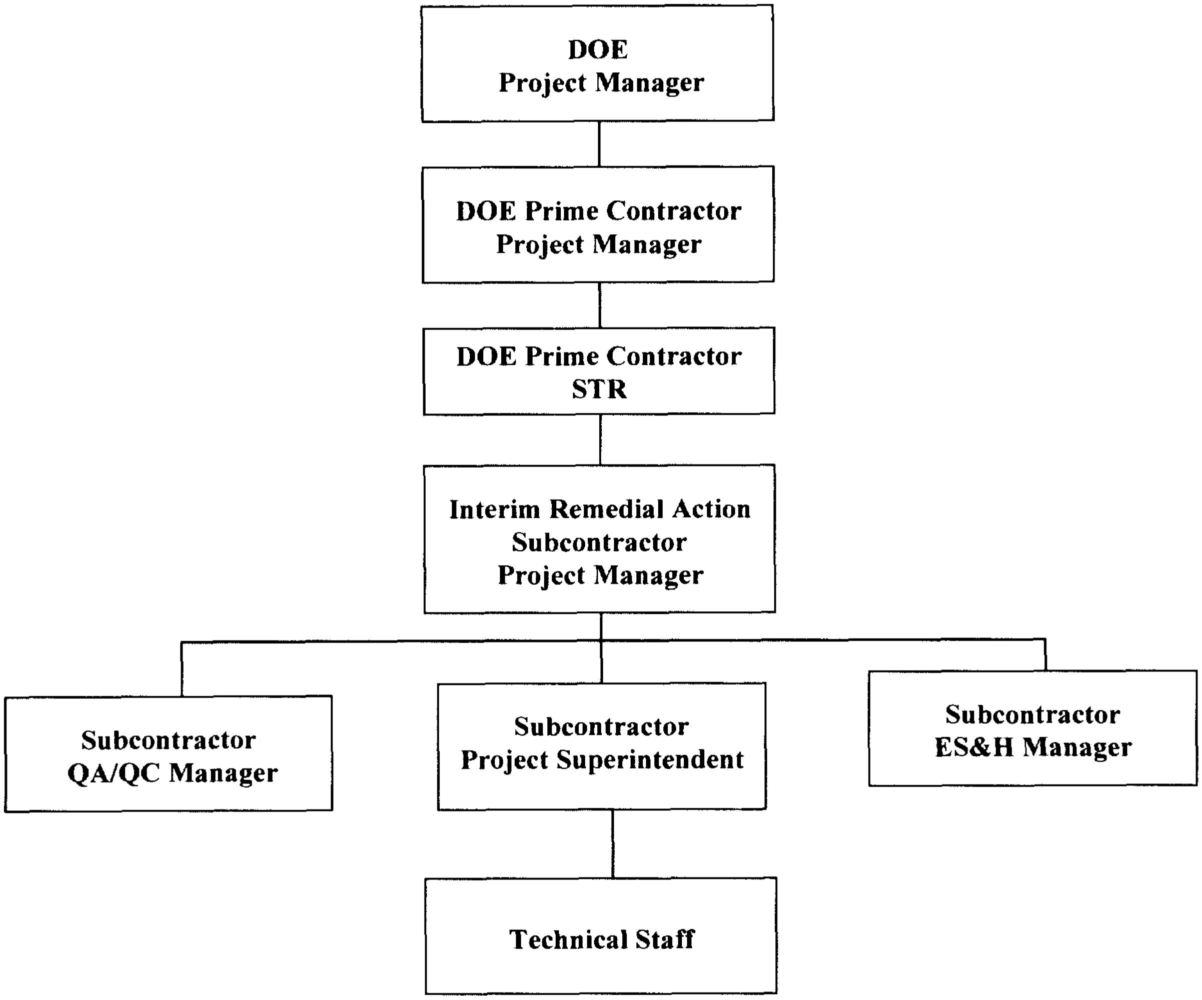


Fig. 3. Project organization.

- Subcontractor ES&H Manager – Develops the ES&H Plan and oversees implementation of Integrated Safety Management Systems and the overall safety and health of employees, both in the field and the office. Provides direct support to the Subcontractor Project Manager concerning the safety and health of project personnel and the general public, and impacts to property and the environment. Ensures that each task has the proper ES&H controls in place before work begins, meeting all federal, state, and local regulations.

- Subcontractor Technical Staff – Provides direct support to the Project Superintendent and Subcontractor Project Manager concerning technical aspects of the project during remedial design, construction, and operation.

2. SITE BACKGROUND

This section summarizes the site background for the area surrounding the C-400 Cleaning Building where the interim remedial action will be conducted. A brief description is provided of the surface and subsurface features of the site and the nature and extent of VOC contamination in the C-400 Cleaning Building area that will be addressed by this action. Also provided is the plant site background and history associated with the C-400 Cleaning Building. This information is based on data from the ROD (DOE 2005a).

2.1 SITE HISTORY AND DESCRIPTION

The PGDP is located in McCracken County in western Kentucky, about 4 miles south of the Ohio River and approximately 10 miles west of the city of Paducah. The plant has produced enriched uranium since 1952. Most industrial activities are sited in a 750-acre security area and buffer zone that are restricted from public access. DOE currently leases the plant production operation facilities to the United States Enrichment Corporation. BJC is the current DOE prime contractor for the environmental restoration and waste management activities at the plant.

The C-400 Cleaning Building is located inside the plant secured area, near the center of the industrial section of PGDP. The building is bound by 10th and 11th Streets to the west and east, respectively, and by Virginia and Tennessee Avenues to the north and south, respectively. Figure 2 shows the location of the C-400 Cleaning Building.

Historically, some of the primary activities associated with the C-400 Cleaning Building were cleaning machinery parts, disassembling and testing of cascade components, and laundering plant clothes. The building has also housed various other activities, including recovery of precious metals and treatment of radiological waste streams.

Suspected sources of leaks and spills at C-400 include (1) degreaser and cleaning tank pits, (2) drains and sewers, (3) the east side plenum/fan room basement, (4) tanks and sumps outside the building, and (5) various first-floor C-400 processes. The two most significant sources of leaks and spills of VOCs that have been identified are located at the southeast corner of the building where a drain line from the degreaser sump was connected to a storm sewer and also where the transfer pumps and piping delivered solvents to and from storage to processes in the building.

Several investigations have occurred in the C-400 Cleaning Building area. In June 1986, a routine construction excavation revealed TCE soil contamination that was determined to be caused from a drain line leak from a C-400 Cleaning Building basement sump to the storm sewer. Four borings were installed to better define the extent of soil contamination. Some of the soils were excavated in an attempt to reduce the contamination in the area; however, excavation was halted to prevent structural damage to the adjacent infrastructure. The excavation was backfilled with clean soil, and the area was capped with a layer of clay.

The Phase I and Phase II CERCLA Site Investigations (MMES 1991, MMES 1992) included installing soil borings and groundwater wells in the area around C-400 Cleaning Building. The investigations confirmed that TCE contamination at the southeast corner of the C-400 Cleaning Building extended from the surface to the base of the RGA at 92 ft below ground surface (bgs). In 1995, an investigation demonstrated that the area around the C-400 Cleaning Building was a potential major source for the Northwest Plume. The *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant* (DOE 1999a) documents an investigation conducted in 1997, which identified the TCE transfer system at the southeast corner of the C-400 Cleaning Building as a significant source of soil and groundwater contamination. An additional area of soil contamination comprised of TCE and other VOCs associated with a storm sewer was identified near the southwest corner of the building.

In addition, four treatability studies were conducted to investigate methods for reducing or remediating the contamination comprised of TCE and other VOCs in the area near the C-400 Cleaning Building. The treatability studies are documented in the following:

1. *In-Situ Decontamination of Sand and Gravel Aquifers by Chemically Enhanced Solubilization of Multiple-Component DNAPLs with Surfactant Solutions* (Intera 1995)

2. *Surfactant Enhanced Subsurface Remediation Treatability Study Report for the Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1999b)

3. *Bench Scale In-Situ Chemical Oxidation Studies of Trichloroethene in Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 1999c)

4. *Final Report Six-Phase Heating Treatability at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2004b).

2.2 SITE SURFACE AND SUBSURFACE FEATURES

In the area of the C-400 Cleaning Building, the topography is relatively flat, with elevations ranging from approximately 370 to 376 ft above mean sea level. Thick concrete aprons cover the heavy traffic areas immediately north and south of the building, while gravel or asphalt cover the areas on the east and west sides of the building. A variety of utility lines are buried on all sides of the building. An active railroad track serves the south side of the building, and an overhead gantry crane and loading dock also are present along the south side of the building. Aboveground steam lines run along the west side of the building. Most of the storm water from the C-400 Cleaning Building area flows to storm drain inlets around the building and discharges via the storm sewer on the south side of the building to Outfall 008, then to Bayou Creek on the west side of the plant. Runoff from the north side of C-400 Cleaning Building flows into the North-South Diversion Ditch, and from there is then pumped to the C-616 Lagoons and released through Outfall 001 to Bayou Creek.

The C-400 Cleaning Building area is underlain by a sequence of clay, silt, sand, and gravel layers deposited on limestone bedrock. As shown in Fig. 4, the sediments above the limestone bedrock are grouped into three major stratigraphic units (loess, continental deposits, and McNairy Formation), based on how the sediments were deposited, and three major hydrogeologic units (HUs) (the UCRS, the RGA, and the McNairy Flow System), based on how water moves within the sediments. The first stratigraphic unit consists of fill and a layer of wind-deposited, silty clay, or loess, extending from the surface to a depth of approximately 20 ft. Beneath the loess, the upper continental deposits, a subunit of the continental deposits consisting of discontinuous sand and gravel layers interbedded with silt and clay, extend to an average depth of 55 ft bgs.

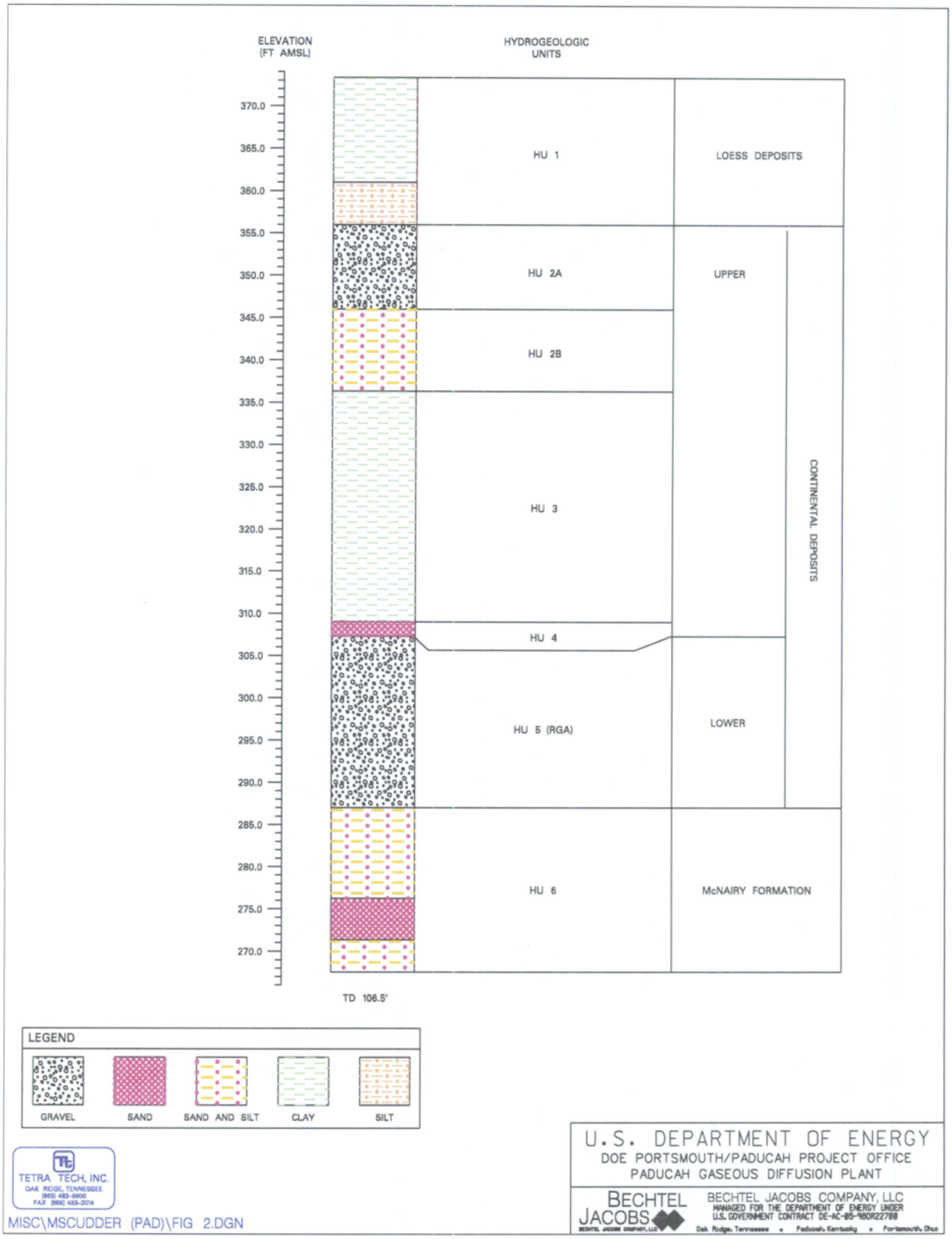


Fig. 4. Hydrogeologic units.

The lower continental deposits, also a subunit of the continental deposits, is a highly permeable layer of gravelly sand or chert gravel, typically extending from approximately 55 to 92 ft bgs. Below the continental deposits is the McNairy Formation, a sequence of silts, clays, and fine sands that extends from approximately 92 to 350 ft bgs. The shallow groundwater system at the site, the UCRS, is subdivided into the HU1, HU2, and HU3 units and consists of the loess (HU1) and the underlying upper continental deposits (HU2 and HU3). The sand and gravel lenses of the HU2 unit are separated from the underlying RGA by a 12- to 18-ft thick silty or sandy clay interval designated as the HU3 aquitard (Fig. 4). The aquitard restricts the vertical flow of groundwater from the sands and gravels of the HU2 unit to the gravels of the RGA. In some limited areas, notably the southeast corner of C-400, the HU3 aquitard is considerably thinner and a lesser barrier to groundwater movement. The RGA, the uppermost aquifer in the C-400 area, consists of the lower continental deposits stratigraphic unit. Below the RGA is the McNairy Flow System, which corresponds to the McNairy Formation. The uppermost portion of the McNairy Flow System typically is a clay or silty clay, which acts as an aquitard restricting groundwater flow between the RGA and McNairy Flow System.

The depth of the shallow water table within the UCRS varies considerably across PGDP. In the C-400 Cleaning Building area, ground covers and engineered drainage limit rainfall infiltration. The shallow water table generally is encountered at depths of approximately 40 to 50 ft bgs. Water within the UCRS tends to flow downward to the RGA. Groundwater flow in the RGA generally is to the north, eventually discharging into the Ohio River. At the C-400 Cleaning Building area, groundwater flow is generally to the northwest as part of the Northwest Plume, although there is evidence for some divergent flow to the east and possibly to the west as part of the Northeast and Southwest Plumes, respectively.

2.3 CONTAMINANTS OF CONCERN

Sampling conducted during the WAG 6 Remedial Investigation at the C-400 Cleaning Building area (DOE 1999a) indicates that primary site-related contaminants in subsurface soil and groundwater at the unit include TCE and its breakdown products. Therefore, this action is focused on the VOC contamination around the C-400 Area.

The TCE present in the soil and groundwater addressed by this interim remedial action originated from activities formerly conducted at PGDP that included the use of TCE as a degreaser and as a cleaning solvent. Spills of unused TCE are also documented. The highest concentrations of VOCs in the soil as provided in Table 1 were found in the southeast and southwest sectors (Sectors 4 and 5, respectively) of the C-400 Cleaning Building area. The southeast sector contains Solid Waste Management Unit (SWMU) 11 and the TCE transfer pumps and piping. The southwest sector contains an area of soil contamination that has not been linked to a particular C-400 Cleaning Building process. Smaller, less significant areas of VOC soil contamination were identified on the east and west sides of C-400 Cleaning Building, as well as near the northwest corner of the building (DOE 2004b).

The elevated concentrations of TCE and its breakdown products in subsurface soils suggest that DNAPL source areas exist within the UCRS soils of the southeast and southwest sectors of the C-400 Cleaning Building area. DNAPLs are liquid chemicals that do not readily dissolve in water and are denser than water. Once in the ground, DNAPLs can migrate downward through the subsurface, with a portion being trapped in the pore spaces in the soil and the remaining portion continuing to migrate downward until further flow is prevented by soil characteristics or the volume of DNAPL is depleted. The TCE concentrations detected in the RGA during the WAG 6 Remedial Investigation, a maximum of 701,000 ppb in groundwater (64% of the maximum solubility of TCE in water) in the southeast sector, suggest that the DNAPL has penetrated the RGA and is acting as a secondary source of groundwater contamination.

Table 1. Maximum VOC contaminant levels in soils at C-400 Cleaning Building area

Contaminant	Contaminant concentrations (ppm) in soil		Contaminant concentrations (ppb) in water	
	Southeast sector (Sector 4)	Southwest sector (Sector 5)	Southeast sector (Sector 4)	Southwest sector (Sector 5)
TCE	11,055	168	701,184	24,473
trans-1,2-DCE	102	15	1200	53
Vinyl chloride	29	<1	133	8
cis-1,2-DCE	2	1	195	ND
1,1-DCE	<1	<1	154	5

DCE = dichloroethene
ND = not detected
ppm = parts per million

2.4 SUMMARY OF SIX PHASE HEATING TREATABILITY STUDY

The primary objective of the Six-Phase Heating Treatability Study that was conducted in 2003, as outlined in the *Treatability Study Work Plan* for *Six-Phase Heating, Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2001b), was to demonstrate the implementability of the Six-Phase Heating technology in the unsaturated and saturated soils of the UCRS and in the groundwater of the underlying RGA. According to the results documented in the *Final Report Six-Phase Heating Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE 2004b), the successful implementation of the study demonstrated that Six-Phase Heating can effectively heat soil in the UCRS and groundwater in the RGA. Data produced during the treatability study indicated that the system can successfully recover and treat steam and the target contaminant vapors. This treatability study removed over 22,000 pounds of TCE (approximately 1900 gal.) from the subsurface in a 43-ft diameter treatment area in the southeast corner of the area near the C-400 Cleaning Building (DOE 2004b).

According to the Six-Phase Heating Treatability Study (DOE 2004b), the removal of TCE in the groundwater of the RGA was assessed by a comparison of the baseline groundwater sample results to post treatment groundwater sampling results. The post treatment sample results indicated a 99.1% reduction in TCE concentration in groundwater, which met the removal efficiency criteria outlined in a Six-Phase Heating Technology Assessment (GEO 2003). Two subsequent rounds of groundwater sampling were performed following the post-treatment sampling event. The analytical results from these two sampling events indicated slight fluctuations in the reduction percentages with the two-week concentrations indicating 99.2% and the four-week concentrations indicating 99.0%.

The Six-Phase Heating Treatability Study (DOE 2004b) also assessed the removal of TCE in the soil by a comparison of the baseline soil sample results to the post treatment soil sample results. This comparison indicated an average TCE concentration reduction in soil of 98%, from an average of 125,111 ppb to an average of 2493 ppb.

The treatability study included the installation and operation of a single Six-Phase Heating array that consisted of six power electrodes, a central neutral electrode, an electrical power control unit, a steam and contaminant recovery system, pressure and temperature monitoring systems, and contaminant vapor and water treatment systems. A total of 35 borings were installed: four groundwater and soil temperature monitoring wells; seven electrode and co-located vapor recovery wells; 15 vacuum monitoring piezometers; and nine post-test assessment borings. The treatability study was implemented to test the effectiveness of Six-Phase Heating technology in the unique hydrogeology located at the southeast corner of the C-400 Cleaning Building. The electrodes were constructed to a depth of 99 ft and consisted of six depth-discrete Electrical Resistance Heating intervals covering the UCRS, the RGA, and the upper interbedded silt, sand, and clay layer of the McNairy formation.

As power was applied to the electrodes, the soil matrix became an electrical resistance heater, raising the temperature of the soil within the treatment area to a level that caused contaminated groundwater to boil and the target contaminants to be volatilized. The contaminants and steam were then removed from the subsurface using vapor recovery wells. The steam was condensed, and the liquid and vapor waste streams were then treated separately.

The scale of the treatability study involved integration and performance of the components of a full-scale multiple electrode Electrical Resistance Heating system in a single treatment area field test. The volume of soil treated was governed by the power delivery capability of the Six-Phase Heating transformer. For the treatability study, the Six-Phase Heating array treatment area was 30 ft in diameter, heating a subsurface treatment area measuring 43 ft in diameter. Examples of operational features that were included in the Six-Phase Heating treatment system design in order to conduct the study safely and efficiently at the southeast corner of the C-400 Cleaning Building area included the following:

- Exhaust of the treated vapor stream was continuously monitored by a photoacoustic analyzer so that if the vapor stream exceeded the alarm set points, the analyzer would trigger an alarm and the system would automatically shut down and operators would be notified through an automated system.

- Vapor treatment process was maintained at a slight vacuum (negative pressure) so that in the event of a leak, outside air would be drawn into the piping and vessels instead of releasing TCE vapors to the atmosphere prior to treatment.

- Negative pressure vapor treatment process provided the ability to dilute the vapor stream for optimal loading of the granular activated carbon vessels.

- Fifteen vacuum piezometers were installed within and around the treatability study area to monitor temperature increases and steam migration along the UCRS and the RGA interface.

- Piezometers within the treatment area contained screens and were connected to the vacuum recovery system to collect any potential steam migration before it exited the treatment area.

According to the Six-Phase Heating Treatability Study (DOE 2004b), the constructability of a full-scale application of a Six-Phase Heating system should only be impaired by the accessibility to the south side of the C-400 Cleaning Building during electrode installation. Electrodes would be installed in the areas of highest contaminant concentration based on existing plume maps, historic and treatability study data. A large bay door on the south side of the C-400 Cleaning Building would be obstructed during electrode installation and system construction. Angled electrode borings and other construction methods could be implemented to minimize the impact to the C-400 Cleaning Building operations. Angled electrode borings could be used to remediate areas under the outside TCE-storage tank, gantry crane, building bay door, and loading pad without requiring demolition. Angled electrodes could also be used to extend the treatment area 20–30 ft under the C-400 Cleaning Building footprint.

The Six-Phase Heating Treatability Study (DOE 2004b) details the following lessons learned and recommendations for incorporation into the full-scale design:

- A hydraulic control system could be incorporated into the full-scale design to prevent the spread of heated groundwater; however, the cost of such a system may not be justified because of the lack of detrimental effects shown during the treatability study.

- The electrode design should be adapted in a full-scale application to prevent the electrical connection, settling, and weight issues discovered during the Six-Phase Heating Treatability Study.

- Incorporate a treatment area cap where shallow vapor recovery is necessary, to prevent the influx of sediments into the treatment system and therefore minimize clogging system components.

The C-400 Cleaning Building area has a unique hydrogeology and therefore required that the Six-Phase Heating Treatability Study incorporate several unique design features. Unique characteristics of the C-400 Cleaning Building area lithology included the extremely high permeability of the RGA, which is overlaid by the lower permeability UCRS and included the depth of desired treatment (98 ft). The treatability study incorporated several electrode features to reduce the potential for the spread of TCE vapors such as co-located vapor recovery wells in the same borehole. Because of concerns regarding the potential for steam and TCE vapor to spread laterally during the study, 15 vacuum piezometers were installed at the site. Also, due to the depth of treatment, six different electrode elements were included to independently direct heat to various depth zones. The design also allowed for the 89–98 ft electrode interval to be heated before the electrode interval above it to provide a thermal barrier or "hot floor" to prevent potential downward DNAPL migration. In addition, the design included a combination of borings used for electrodes and vacuum recovery functions.

3. TECHNICAL APPROACH TO REMEDIAL DESIGN

3.1 REMEDIAL DESIGN OBJECTIVES

The interim remedial action technical approach for reducing VOCs at the C-400 Cleaning Building has the following primary objectives:

- Reduce exposure to contaminated groundwater by reducing the source concentrations of TCE and other VOCs in the RGA in the C-400 Cleaning Building area, thereby reducing the migration of these contaminants to off-site points of exposure;

- Prevent exposure to contaminated groundwater to on-site industrial workers through institutional controls (e.g., excavation/penetration permit program); and

- Reduce contamination comprised of TCE and other VOCs found in UCRS soil at C-400 Cleaning Building area to minimize the migration of these contaminants to RGA groundwater and to off-site points of exposure.

The contamination by TCE in the C-400 Cleaning Building area source zone is present as DNAPL and dissolved in groundwater. EPA recognizes that DNAPL is a significant technical challenge for both characterization and remediation. DOE anticipates that the proposed interim remedial action will remove a significant portion of the TCE and other VOCs in the C-400 Building area source zone but will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure.

The following LUC objectives are necessary to ensure the protectiveness of the selected remedy but are not within the scope of the remedial design:

- Maintain the integrity of any current or future remedial or monitoring system;
- Prohibit the development and use of the C-400 Cleaning Building for residential housing, elementary and secondary schools, child care facilities, and playgrounds;
- Prevent exposure of current and future on-site industrial workers to groundwater and prevent use of the groundwater at the C-400 Cleaning Building area through institutional controls (e.g., the current excavation/penetration permit program) and through deed restrictions; and
- Provide notice in property records regarding contamination and response actions at the C-400 Cleaning Building area.

The objective of this remedial design is to develop the necessary procurement specifications that are required for inclusion in a bid package for a subcontractor to design, build, and operate an Electrical Resistance Heating system at the C-400 Cleaning Building. The Electrical Resistance Heating system may take the form of six-phase or three-phase heating and/or combinations of both to implement the remedy. The total project will be inclusive of operational procedures and the necessary technical support for successful project completion and remedy implementation.

3.2 REMEDIAL DESIGN APPROACH

Consistent with the results of the Groundwater OU Feasibility Study (DOE 2001a) and the subsequent successful Six-Phase Heating Treatability Study (DOE 2004b), the selected remedy focuses on reducing the concentration of TCE and other VOCs in the source soils in the UCRS and RGA at the C-400 Cleaning Building area, which has been identified as the major source of groundwater contamination at the PGDP. The C-400 is located within the plant secured area. The major components of the selected remedy include the following:

- Removal and treatment of TCE and other VOCs in the contaminant source zone in the UCRS and RGA at the C-400 Building area using Electrical Resistance Heating in both the UCRS and RGA;
- Collection of post-action sampling results;
- A remedial design investigation to further determine areal and vertical extent of TCE and other VOC contamination in the C-400 Cleaning Building area to determine optimum placement of the remediation system; and
- Implementation, maintenance, and reporting of LUCs at the C-400 Cleaning Building area.

The C-400 Cleaning Building interim remedial action for VOC reduction detailed in this RDWP will include the six-phase Electrical Resistance Heating system as well as the potential for a three-phase electrical heating system or a combination of both. The optimum mix of the two technologies utilized at the C-400 Cleaning Building area will be determined during the design phase of the treatment system. The system(s) will be specified based upon the best available technology and experiences from the six-phase trial successfully completed in March 2004. The C-400 Cleaning Building area Six-Phase Treatability Study achieved a TCE removal efficiency of 98% in UCRS soils in the treatability study test cell. It is likely that Electrical Resistance Heating, when applied over the larger area of the C-400 Cleaning Building source zone, will not reduce groundwater TCE concentrations to its Maximum Contaminant Level (MCL); however, permanent removal of a significant portion of the TCE from groundwater at the C-400 Cleaning Building area source zone will shorten the time required to attain the MCL for groundwater (DOE 2004b).

In both applications, the technology uses *in situ* heating to raise the temperature of the soil to a level where the target contaminant(s) are volatilized. Common power sources may be used to heat the ground, producing *in situ* steam to liberate the contaminants, which are removed by way of a vapor recovery system. The technology can be deployed in the vadose and saturated zones and may be used in moist soils with either low or high permeability.

The three-phase heating system consists primarily of a network of in-ground electrodes and co-located vapor extraction wells distributed throughout the zone of contamination. This is the preferred electrical phasing method for large and noncircular remediation areas.

Six-phase heating typically utilizes arrays of six electrodes located in a hexagonal shape with a neutral electrode located in the center of the hexagon serving as a vapor extraction well. A typical array diameter is 25–35 ft, with the heated zone being approximately 40% larger than the array diameter. It is the preferred electrical phasing method for smaller, discrete areas.

Electrical Resistance Heating includes the following components:

- Installation of electrodes and vapor extraction wells in the source zone comprised of TCE and other VOCs at the C-400 Cleaning Building area. The estimated volume of soil to be treated at the source zone locations assuming a 100 ft treatment depth is approximately 80,000 yd^3;

- Heating of subsurface soil, contaminants, and groundwater via application of electrical current to the UCRS and RGA soils;

- Withdrawal of volatilized TCE and other VOCs from the vadose zone by high vacuum (approximately 20–25 in. of mercury) extraction to prevent migration from the treatment zone;

- Treatment of contaminated soil vapor through the use of an above ground treatment system;

- Monitoring of contaminants in groundwater and air;

- Discharge of treated groundwater through a Kentucky Pollutant Discharge Elimination System permitted outfall;

- Waste classification for on-site and off-site disposal; and

- Discharge of treated vapors to the atmosphere.

The off-gas volatile concentrations are used as a measure to determine when sufficient heat has been applied to the subsurface such that additional heating would not be productive or cost effective. Operation of the Electrical Resistance Heating array would cease when the monitoring system indicates that heating has stabilized in the subsurface and the contaminant recovery diminishes to a point where significant additional decreases in this rate of recovery are not anticipated (i.e., the rate of removal of TCE and other VOCs becomes asymptotic). Treatment time is estimated to be from 6 months to one year.[1] A significant extension of treatment time may require reconsideration of the cost-effectiveness of the selected remedy.

Work will include specifying the scope and providing the procurement specifications for a design-build and operate performance-type subcontract. The successful bidder will provide the design specifications and construction drawings necessary for a Certified for Construction (CFC) package with the integration of DOE Prime Contractor requirements and necessary project submittals. In addition, a detailed project cost estimate breakdown will be developed based on new information and data collected during the engineering design of the remedial alternative.

The design will be accomplished using a phased approach (e.g., 30%, 60%, and 90%). Upon final design approval, the design will be certified for construction and the bidder will be given permission for final procurement and bidding to lower-tier subcontractors to begin construction activities. The general Contractor will be responsible for coordination of all submittals, work activities, and management of all lower tier subcontractors.

During this process, the Subcontractor will develop a schedule for construction, an Operation and Maintenance (O&M) Plan, and the required procedures and DOE Prime Contractor readiness reviews for start-up and operation. The O&M Plan will include a Compliance Plan that incorporates a discussion of substantive requirements that the action will meet and the administrative requirements that are exempted for the action under Section 121(e)(1) of CERCLA .

An operational Sampling and Analysis Plan will be developed and submitted to the regulators for review and comment. The plan will include the necessary field collection data requirements and reports to be submitted as specified in the procurement package.

[1] Timeframes set forth herein are for estimation purposes only. Enforceable schedules are set forth in the FFA.

3.3 REGULATORY CONSIDERATIONS DURING REMEDIAL DESIGN

3.3.1 Compliance with ARARs

During the design phase, the Subcontractor will review the ARARs identified in the ROD (DOE 2005a) to ensure that appropriate requirements are addressed in the design.

3.3.2 Regulatory Permitting Considerations

This interim remedial action satisfies the mandates of CERCLA Section 121 and, to the extent practicable, the requirements of the National Contingency Plan to be protective of human health and the environment. The action will contribute to the final remediation of the Groundwater OU by removing a significant portion of the contaminant mass of TCE and other VOCs at the C-400 Cleaning Building area through treatment. This will reduce the period the TCE concentration in groundwater remains above its MCL and meets the statutory preference for attaining permanent solutions through treatment. The action will meet federal and state ARARs for the scope of this interim action. Although this interim action will not meet the MCL in groundwater for TCE, the action satisfies the requirements set forth in 40 CFR 300.430(f)(l)(ii) for interim measures that will become part of the total remedial action that will attain ARARs, including the MCL for TCE, or satisfy the requirements for an ARARs waiver. Based on currently estimated costs, the selected remedy is cost effective because it represents a reasonable value for the money to be spent. In addition, this interim remedial action is consistent with RCRA corrective action requirements and the Hazardous and Solid Waste Amendments Permit for affected SWMUs.

As noted above, additional assessment of the C-400 Cleaning Building area will be included in the Groundwater OU and/or Comprehensive Site-Wide OU. The interim action will permanently remove a significant portion of the TCE and other VOCs in the C-400 Cleaning Building area through treatment, but will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure. The interim action meets the preference for remedies that employ treatment as a principal element of the remedy that reduces toxicity, mobility, or volume of a hazardous substance, pollutant, or contaminant.

Because contamination above levels that allow for unrestricted exposure will remain after completion of the action, statutory reviews will be conducted every five years after initiation of the interim remedial action to ensure that the remedy continues to be protective of human health and the environment.

3.4 DESIGN CRITERIA AND ASSUMPTIONS

Design and construction considerations that are applicable to Electrical Resistance Heating include the following:

- Extent of VOC source zone contamination in the UCRS and the RGA;
- Spacing and placement of electrodes and extraction wells to achieve optimum removal efficiency;
- Electrical conductivity of the soil being treated;
- Location of a local power supply;
- Sizing of treatment systems, pumps, and demisting system for soil vapor;
- Water treatment system discharge;
- Air emissions; and
- Waste classification for on-site versus off-site disposal.

Assumptions utilized in the development of this RDWP include the following:

- The RDWP is developed based upon the selected alternative and background information included in the approved ROD (DOE 2005a).
- The system(s) will be specified based upon the best available technology and results from the Six-Phase Heating Treatability Study (DOE 2004b).
- The design will include a six-phase Electrical Resistance Heating system as well as the potential for a three-phase electrical heating system or a combination of both.
- The best available technical information of the existing site will be obtained from the Six-Phase Heating Treatability Study (DOE 2004b).
- The criteria and approach to determine when to cease operation of the Electrical Resistance Heating in accordance with the ROD will be addressed in the 60%, 90%, and CFC Remedial Design Reports.
- Power requirements will be determined by the successful bidder, and the DOE Prime Contractor will provide the energy source. All necessary construction and tie-ins will be integrated and coordinated by the successful bidder. All other utilities will be supplied by the Subcontractor.
- DOE Prime Contractor will provide the Sampling and Analysis Plan to the Subcontractor for the Remedial Design Support Investigation.
- An O&M Plan will be developed to evaluate system performance.
- A detailed project cost estimate will be provided with the 90% and final design package.
- New sources of contamination will not be added that will increase the presence levels of contamination.
- The Remedial Design Support Investigation Work Plan will be developed by others but implemented by the Subcontractor.

A Remedial Design Support Investigation will be performed to further determine areal and vertical extent of TCE and other VOC contamination in the C-400 Cleaning Building area to determine optimum placement of the remediation system. Results will be documented in the RAWP and will provide the basis for adjusting the area to be treated. The RAWP will provide in-depth discussion concerning the crosswalk from levels found in the subsurface soils and groundwater to that of an area requiring Electrical Resistance Heating.

4. REMEDIAL DESIGN PLANNING

The remedial action to apply Electrical Resistance Heat technology to remediate the subsurface volatile contamination in the C-400 Cleaning Building area will be subcontracted by BJC or other DOE Prime Contractor as a design-build and operate package. Work will not proceed on the construction until the DOE, EPA, and KDEP have issued a concurrence to proceed with the implementation of the remedial action following completion of the RDR by the subcontractor.

4.1 PROCUREMENT

A design-build and operate procurement specification outlining the scope and schedule and the necessary Technical Requirements will be developed by BJC or other DOE Prime Contractor. This will establish the scope and technical approach for the design, construction, and operation of the remediation treatment system.

A pre-bid meeting with the qualified bidders will be conducted by BJC or other DOE Prime Contractor. The meeting will include a site walk-down and dissemination of existing information and documentation for developing subcontractor bids. All questions will be answered, issues resolved, and information submitted prior to receipt of bids.

Following receipt of bids, a BJC or other DOE Prime Contractor project evaluation team will evaluate the bids and award based upon technically evaluated procurement criteria. The successful bidder will provide the required subcontract submittals for Contractor review/acceptance and required approvals.

4.2 SCOPING MEETING

Once the design-build and operate subcontract is awarded, a Kickoff Meeting will be held. During the meeting, the project schedule will be established and the final design criteria will be accepted. Any clarifications or questions concerning project scope will be addressed. Since this remedial design requires a design-build subcontract, the design package will be CFC by the Subcontractor, and installation of the selected remedy will begin.

4.3 CONSTRUCTION OVERSIGHT

After the RDR is approved and proper readiness reviews are completed along with the necessary pre-mobilization submittals, the Subcontractor will be given a notice to proceed and construction will begin. Field Services personnel from DOE Prime Contractor's Engineering and Construction functional group will provide the required oversight during construction activities. This same level of oversight will also be supplied by the DOE Prime Contractor during the timeframe in which remedial operations are occurring.

5. REMEDIAL DESIGN

The subcontractor will provide an RDR based on a design-build and operate approach. The approved RDR will include the CFC drawings and specifications. The DOE, EPA, and KDEP will receive a copy of the CFC package at the completion of design and a final "as-built" package at the completion of construction. The final (i.e., CFC) drawings and specifications will be sealed/stamped by a Professional Engineer registered in the Commonwealth of Kentucky.

The design process will entail the typical 30%, 60%, 90% and CFC design packages. The 90% design shall represent the D1 Remedial Design Report. The 30% and 60% design shall represent secondary Intermediate Remedial Design Reports and will be subject to a 7-day review/comment period by the regulators, in lieu of the standard review timeframe (90 days) specified for secondary documents under Section XX.G. of the FFA. The reviews will be completed in a timely manner such that comments will not result in negative impacts to the overall project schedule.

5.1 DESIGN DELIVERABLES

The CFC RDR will be developed to provide the drawings and specifications required to construct the Electrical Resistance Heating remediation system for the C-400 Cleaning Building area. Also included within the RDR is a section that details the operational characteristics that will be utilized in determining the completion of effective operations or shut-down criteria of the system. As part of the RDR, the O&M Plan will be developed. The design team must adhere to all DOE Prime Contractor Technical Specifications as required during completion of the remedial design. In addition, the design must ensure that each ARAR is implemented as design progresses.

The design will be prepared and issued for review in three stages. The preliminary design of the treatment system will be initiated with the development of the major elements of the project. Preliminary design will continue until the design is approximately 30% complete. The preliminary design phase submittal will include an outline of the performance type specification, a table of contents, and an index of sections. The specification will define the qualitative requirements for products, materials, and workmanship upon which the construction will be based. The specifications will be prepared in Construction Specifications Institute format and will be organized in 18 major divisions. Following an on board review of the preliminary design, the design will proceed to approximately 60% complete. At this point, the intermediate design will be issued for regulator review. Following review, a comment resolution meeting will be conducted (as necessary), and the design will proceed to pre-final or 90% design, which shall represent the D1 Remedial Design Report.. At 90% design review, the design will be issued for regulator review. After that regulatory review of the D1 Remedial Design Report, if the document is approved, the design will be certified for construction and issued as final. If the regulators issue comments on the D1 Remedial Design Report, comments will be addressed and a D2 Remedial Design Report issued for regulator approval. Upon regulator approval of the D2 Remedial Design Report, the design shall be certified for construction and issued as final. The final drawings and specifications will be sealed/stamped by a Professional Engineer registered in the Commonwealth of Kentucky.

5.2 REMEDIAL ACTION WORK PLAN

The RAWP will address the following:

- A list of each ARAR, the citation that mandates the ARAR, and as appropriate, the drawing and/or specification that contractually implements or meets the substantive requirements of the ARAR;
- The asymptotic target for the contaminant mass removal from the subsurface based on technology capability and the expected site conditions. This should include, to the extent possible, the technological analysis used to support the proposed setting;
- A description of the monitoring and testing that will be utilized to determine if the projected contaminant mass removal has been successful, and independent verification protocols to ensure that remediation goals were attained;
- A summary level description of the program-specific plans such as the Construction Environmental Monitoring approach, the Best Management Practices approach, the Waste Management approach, and other plans and work guides that may be required to implement the interim remedial action.
- The O&M Plan that will describe the site operations necessary to perform the contaminant removal destruction, and waste management in a safe and compliant manner.
- The Remedial Design Support Investigation results and the detailed description of the treatment area and any changes in area from that documented in the approved ROD.

5.2.1 Environmental, Safety, and Health

To avoid the risk of bodily harm to employees associated with this interim remedial action, other personnel, and the general public and damage to property or the environment, the Subcontractors will ensure the federal, state, and local ES&H regulations that apply to this interim remedial action are designed into extraction and treatment systems and implemented during the course of this work. The Subcontractors shall follow, at a minimum, requirements associated with the handling of TCE, as well as other identified or unidentified hazards associated with this remedial action. These hazards will be identified in Activity Hazard Analysis forms prepared by the designated subcontractor and incorporated into the project health and safety plan prior to start of field activities.

5.2.2 Environmental Compliance

As defined in the signed ROD (DOE 2005a), this interim action satisfies the requirements in 40 CFR 300.430(f)(1)(ii) for interim actions to meet ARARs. The subcontractors performing this interim remedial action shall comply with the approved ARARs. The subcontractors will prepare an Environmental Compliance Plan as part of the RAWP that identifies and describes activities to be implemented to comply with all ARARs and TBCs.

5.2.3 Waste Management

The subcontractors will submit a Waste Management Plan as part of the RAWP that describes the quantities of waste materials expected to be generated during construction and operations and the strategy for management, treatment, and disposal of the wastes. The strategy shall ensure the protection of the worker, the environment, and the public. Waste generated from the removal action will be characterized in accordance with applicable requirements. The Waste Management Plan incorporates requirements for waste characterization, handling, disposal and transportation. The predominant feature of the Waste Management Plan is the waste management plan checklist that contains specific responsibilities for each type of waste generated and for each organization involved in waste management. A Sampling and Analysis Plan will be submitted for review and approval as part of the RAWP to support characterization of waste materials generated and managed as contaminated environmental media or debris.

5.2.4 Quality Assurance

The Subcontractors shall have an established QA/QC program that defines the administrative procedures for implementing and integrating good quality practices throughout the implementation of the interim remedial action work. The subcontractors shall ensure that all activities affecting quality are performed in a controlled and consistent manner and in accordance with all applicable procedures and requirements.

5.2.5 Operations Maintenance and Monitoring Plan

An O&M Plan will be prepared for implementation during the operational phase of the system. O&M requirements for Electrical Resistance Heating system include routine maintenance of pumps, electrodes, pipes, gauges, and treatment units. Depending on the moisture content of the soil, it may be necessary to add small amounts of potable water to the electrodes. The voltage control system and transformers may require maintenance during operation. At the end of the treatment period, the Electrical Resistance Heating system will be decontaminated and decommissioned. The O&M Plan will contain the necessary working procedures and work guides to perform the remedial operations. The plan will be amended following completion of construction and prior to commencing to include the as-built drawings for the system to insure good conduct of operations.

6. REMEDIAL DESIGN SCHEDULE

The schedule for submission of the remedial design is provided in Table 2.

Table 2. Remedial design schedule[1]

Activity	Date
C-400 ROD signed	8/09/05(A)
D1 RDWP	8/11/05(A)
D1 RAWP	11/22/06
Remedial design (Issue 90% CFC Design)	12/8/06
D1 Remedial Action Completion Report	4/26/11

(A) = Actual Date

[1] Timeframes set forth in this table are for estimation purposes only. Enforceable schedules are set forth in the FFA.

7. REFERENCES

Code of Federal Regulations, Title 40, Part 300, National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

DOE 1999a. *Remedial Investigation Report for Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1727&D2, U.S. Department of Energy, Paducah, KY.

DOE 1999b. *Surfactant Enhanced Subsurface Remediation Treatability Study Report for the Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1787&D1, U.S. Department of Energy, Paducah, KY.

DOE 1999c. *Bench Scale In-Situ Chemical Oxidation Studies of Trichloroethene in Waste Area Grouping 6 at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1788&D1, U.S. Department of Energy, Paducah, KY.

DOE 2001a. *Feasibility Study for the Groundwater Operable Unit at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1857&D2, U.S. Department of Energy, Paducah, KY, August.

DOE 2001b. *Treatability Study Work Plan for Six-Phase Heating, Groundwater Operable Unit at Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-1889&D2, Secondary Document, U.S. Department of Energy, Paducah, KY, September.

DOE 2004a. *Proposed Remedial Action Plan for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-2114&D2, Primary Document, U.S. Department of Energy, Paducah, KY, March 2004.

DOE 2004b. *Final Report Six-Phase Heating Treatability Study at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-2113&D2, Secondary Document, U.S. Department of Energy, Paducah, KY, March 2004.

DOE 2005a. *Record of Decision for the Volatile Organic Compound Contamination at the C-400 Cleaning Building at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-2150&D2/R2, Primary Document, U.S. Department of Energy, Paducah, KY, July 2005.

DOE 2005b. *Site Management Plan, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* DOE/OR/07-2197&D1, U.S. Department of Energy, Paducah, KY, April 2005.

GEO (GEO Consultants LLC) 2003. *Six-Phase Heating Technology Assessment, GEO Consultants LLC, Kevil, KY, March 2003.*

Intera 1995. *In-Situ Decontamination of Sand and Gravel Aquifers by Chemically Enhanced Solubilization of Multiple-Component DNAPLs with Surfactant Solutions*, Intera Inc., January 1995.

MMES (Martin Marietta Energy Systems, Inc.) 1991. *Results of the Site Investigation, Phase I, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* KY/ER-4, CH2M Hill Southeast, Inc., Oak Ridge, TN.

MMES 1992. *Results of the Site Investigation, Phase II, Paducah Gaseous Diffusion Plant, Paducah, Kentucky,* KY/SUB/13B-97777CP-03/1991/1, CH2M Hill, Inc., April.

RECORD COPY DISTRIBUTION

File—EMEF DMC